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The Patent Office
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1. Your reference — EH/DS/57543

2. Patent application number
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3. Full name, address and postcode of the or of each applicant *(underline all surnames)* — See attached sheet

THE PATENT OFFICE
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26 OCT 1998
LONDON

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention — ENERGY GENERATION

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

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UNITED KINGDOM

Patents ADP number *(if you know it)* — 117001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application — Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
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YES

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	1
Description	15
Claim(s)	5
Abstract	
Drawing(s)	1 + 1 (8)

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Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
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11. I/We request the grant of a patent on the basis of this application.

Signature Lloyd Wise, Tregear & Co Date 26.10.1998

LLOYD WISE, TREGEAR & CO

12. Name and daytime telephone number of person to contact in the United Kingdom

ESMOND A HITCHCOCK
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ANNEX TO PATENTS FORM 1/77

SECTION 3

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ENERGY GENERATION

The present invention relates to the generation of energy, and more particularly to the release of energy as a result of fusion of light atomic nuclei.

Normally, fusion processes are able to be initiated only at extremely high temperatures, as found in the vicinity of a nuclear fission (uranium or plutonium) detonation. This is the principle of most thermonuclear bombs. Such a release of energy is impractical as a means of providing the power to generate electricity and heat for distribution, as it occurs too rapidly with too high a magnitude for it to be manageable.

In recent years, many attempts have been made to initiate fusion processes at high temperatures by the enclosure of a region of plasma-discharge within a confined space, such as a toroidal chamber, using electromagnetic restraint. Such attempts have met with little success to date and systems which employ such a technique have invariably consumed more energy than they have produced.

Another approach which has been attempted in order to achieve fusion of light nuclei has been the so-called "cold fusion" technique, in which deuterium atoms have been induced to tunnel into the crystal lattice of a metal such as palladium during electrolysis. It is claimed that the atoms are forced together in the lattice, overcoming the repulsive electrostatic force. However, no clear and unambiguous demonstration of successful cold fusion has yet been presented publicly.

The invention provides a method of generating energy comprising the steps of providing an electrolyte having a catalyst therein, the catalyst being suitable for initiating transitions of hydrogen and/or deuterium atoms in the electrolyte to a sub-ground energy state, and applying a voltage across an anode and

cathode in contact with the electrolyte.

The invention further provides a method of generating energy comprising the steps of reducing the electron-path-radius of atoms of hydrogen and/or deuterium in an electrolyte and fusing said atoms within a plasma discharge generated by applying a voltage across an anode and a cathode in the electrolyte.

In addition, a method in accordance with the invention of generating energy comprises the steps of providing an electrolyte having hydrogen and/or deuterium atoms and a catalyst therein, the catalyst comprising an ionic species which provides an energy couple of a multiple of approximately 27.2 eV, and applying a voltage across an anode and cathode in contact with the electrolyte.

According to another aspect, the invention provides a method of inducing transitions of hydrogen and/or deuterium atoms to a sub-ground energy state, comprising providing a liquid comprising hydrogen and/or deuterium atoms, and adding a catalyst which provides an energy couple of a multiple of approximately 27.2 eV.

In carrying out a preferred method in accordance with the invention, it has been found that the process may be assisted by initial heating of the electrolyte prior to applying a voltage across the electrodes. An electrolyte temperature in the range 40 to 80°C has been seen to be particularly beneficial.

The ratio of H_2O to D_2O in the electrolyte may be varied to control the energy generation. In some circumstances it may be preferable to use "light" water H_2O alone and in others to use D_2O alone. Additionally, the amount of catalyst added to the electrolyte may also be varied as a controlling factor. The method preferably utilises hydrogen and/or deuterium atoms in monatomic form, although the diatomic form may also be used.

It may also be advantageous to apply the voltage across the

electrodes in the form of a pulsed waveform which can enhance performance of the system. Preferably, the pulses have a duty cycle of between 0.001 and 0.5.

In preferred embodiments, the method includes the step of generating a magnetic field in the region of the electrodes. The intensity and frequency of the current used to generate the field may be adjusted to move a plasma arc away from the cathode in order to minimise any electrode erosion, and thereby extend the operating life of the system. Only a very slight separation may be required to achieve this effect.

During the methods described herein, atoms of hydrogen and/or deuterium are believed to undergo a fundamental change in their structure. The applicants believe this change and the observed phenomena can be explained as set out below.

It is well known that a system comprising a spherical shell of charge (the electron path) located around an atomic nucleus constitutes a resonant cavity. Resonant systems act as the repository of photon energy of discrete frequencies. The absorbtion of energy by a resonant system excites the system to a higher-energy state. For any spherical resonant cavity, the relationship between a permitted radius and the wavelength of the absorbed photon is:

$$2\pi r = n\lambda$$

where n is an integer
and λ is the wavelength

For non-radiating or stable states, the relationship between the electron wavelength and the allowed radii is:

$$2\pi[nr_1] = 2\pi r_{(n)} = n\lambda_{(1)} = \lambda_{(n)} \qquad (2)$$

where n = 1

or $n = 2, 3, 4 \ldots\ldots\ldots$

or $n = 1/2, 1/3, 1/4 \ldots\ldots\ldots$

and $\lambda_{(1)}$ = the allowed wavelength for n = 1

$r_{(1)}$ = the allowed radius for n = 1

In a hydrogen atom (and the following applies equally to a deuterium atom), the ground state electron-path radius can be defined as $r_{(0)}$. This is sometimes referred to as the Bohr radius, a_0. There is normally no spontaneous photon emission from a ground state atom and thus there must be a balance between the centripetal and the electric forces present. Thus:

$$[m_{(e)} . v_1^2] / r_{(0)} = Ze^2 / (4\pi . \epsilon_{(0)} . r_{(0)}^2) \qquad (3)$$

where $m_{(e)}$ = electron rest mass

v_1 = ground state electron velocity

e = elementary charge

$\epsilon_{(0)}$ = electric constant (sometimes referred to as the permittivity of free space)

Z = atomic number (for hydrogen, 1)

Looking first at the excited (higher energy) states, where the hydrogen atom has absorbed photon(s) of discrete wavelength/frequency (and hence energy), the system is again stable and normally non-radiating, and to maintain force balance, the effective nuclear charge becomes $Z_{eff} = Z/n$, and the balance equation becomes:

$$[m_{(e)} . v_n^2] / nr_{(0)} = [e^2/n] / (4\pi . \epsilon_{(0)} . [nr_{(0)}]^2) \qquad (4)$$

where n = integer value of excited state (1,2,3.....)

v_n = electron velocity in the nth excited state

The absorbtion of radiation by an atom thus results in an excited state which may decay to ground state, or to a lower excited

state, spontaneously, or be triggered to do so, resulting in the re-release of a quantum of energy in the form of a photon. In any system consisting of a large number of atoms, transitions between states are occurring continuously and randomly and this activity gives rise to the observable spectra of emitted radiation from hydrogen.

Each value of n corresponds to a transition which is permitted to occur when a resonant photon is absorbed by the atom. Integer values of n represent the absorbtion of energy by the atom.

Fractional values for n are allowed by the relationship between the standing wavelength of the electron and the radius of the electron-path, given by (2), above. To maintain force balance, transitions involving fractional values for n must effectively increase the nuclear charge Z to a figure Z_{eff}, and reduce the radius of the electron-path accordingly. This is equivalent to the atom emitting a photon of energy while in the accepted ground state, effecting a transition to a sub-ground state. Because the accepted ground state is a very stable one, such transitions are rarely encountered but the applicants have discovered that they can be induced if the atom is in close proximity to another system which acts as a "receptor-site" for the exact energy quantum required to effect the transition.

The emission of energy by a hydrogen atom in this way is not limited to a single transition "down" from ground state, but can occur repetitively and, possibly, transitions to 1/3, 1/4, 1/5 etc states may occur as a single event if the energy balance of the atom and the catalytic system is favourable. Of course, the usual uncertainty principles forbid the determination of the behaviour of any individual atom, but statistical rules govern the properties of any macroscopic ($>10^9$ quanta) system.

When a "ground-state" hydrogen atom emits a photon of around 27eV, the transition occurs to the $a_o/2$ state as demonstrated above and the effective nuclear charge increases to +2e. A new

equilibrium for the force balance is now established. The electron path radius is reduced. The potential energy of the atom in its reduced radius-state is given by

$$V = -\{Z_{(eff)}e^2/[4\pi\epsilon_{(0)}(a_{(0)}/2)]\} = -\{4 \times 27.178\}$$

$$= -108.7 \text{ eV}$$

The kinetic energy, T, of the reduced electron path is given by

$$T = -[V/2] = 54.35 \text{ eV}$$

Similarly, it can be seen that the kinetic energy of the ground state electron path is about 13.6 eV. Thus there is a net change in energy of about 41 eV for the transition:

$$H\{Z_{(eff)}=1;\ r=a_{(0)}\} \quad \text{to} \quad H\{Z_{(eff)}=2;\ r=a_{(0)}/2\}$$

That is to say, of this 41 eV, about 27 eV is emitted as the catalytic transfer of energy occurs, and the remaining 14 eV is emitted on restablisation to the force balance.

The radial "ground-state" field can be considered as a superposition of Fourier components. If integral Fourier components of energy equal to m x 27.2 eV are removed, the positive electric field inside the electron path radius increases by

$$(m) \times 1.602 \times 10^{-19}C$$

The resultant electric field is a time-harmonic solution of the Laplace equations in spherical co-ordinates. In the case of the reduced radius hydrogen atom, the radius at which force balance and the non-radiative condition are achieved is given by

$$r_{(m)} = a_{(0)}/[m+1]$$

where m is an integer.

From the energy change equations given above, it will be appreciated that, in decaying to this radius from the so-called "ground-state", the atom emits a total energy equal to

$$[(m+1)^2 - 1^2] \times 13.59 \text{ eV} \qquad (5)$$

The applicants have found that such energy emissions as take place according to (5), above, only appear to occur when the hydrogen or deuterium is found in the monatomic (or so-called "nascent") state. Molecular hydrogen might be made to behave similarly, but the transition is more difficult to achieve owing to the higher energies involved.

In order to achieve the transition in monatomic hydrogen (H) or deuterium (D), it is necessary to accumulate the molecular form in the gas phase on a substrate such as nickel or tungsten which favours the dissociation of the molecule. As well as being dissociated into the monatomic form, the hydrogen or deuterium should be bound to the catalytic system to initiate the reaction. The preferred method of achieving this is by electrolysis using cathode material which favours dissociation.

The applicants have discovered that the catalytic systems which encourage transitions to sub-ground-state energies are those which offer a near-perfect energy couple to the [m x 27.2] eV needed to "flip" the atom of H or D. It appears from experiment that the effective sink of energy provided by the catalyst need not be precisely equal to that emitted by the atom. Successful transitions have been achieved when there is an error of as much as $\pm$2% between the energy emitted by the atom and that absorbed by the catalytic system. One possible explanation for this is that, in a macroscopic sized system, although the transitions are initiated by a close match in energy level, such discrepancies as arise are manifested as an overall loss or gain in the kinetic energies of the recipient ionic systems. It is thought that

spectroscopic analysis of active H or D catalytic systems may provide evidence of this.

One catalyst that has been found to initiate the transition to the a_0/n state is rubidium in the Rb+ ionic species. If a salt of rubidium, such as the carbonate Rb_2CO_3 is dissolved in either water or deuterium oxide (heavy water), a substantial dissociation into Rb^+ and $(CO_3)^{2-}$ ions takes place. If the Rb^+ ions are bound closely to monatomic H or D, the transition to the a_0/n state is encouraged by the removal of a further electron from the rubidium ion, by provision of its second ionisation energy of about 27.28 eV. Thus:

$$Rb^+ + H\{a_{(0)}/p\} + 27.28 \text{ eV} \rightarrow$$

$$Rb^{2+} + e^- + H\{a_{(0)}/[p+1]\} + \{[(p+1)^2 - p^2] \times 13.59\} \text{ eV}$$

where p represents an integral number of such transitions for any given H and D atom and by spontaneous re-association:

$$Rb^{2+} + e^- = Rb^+ + 27.28 \text{ eV}$$

Thus, the rubidium catalyst remains unchanged in the reaction and there is a net yield of energy per transition.

Other catalytic systems can be used which have ionisation energies approximating to [m x 27.2]eV, such as titanium in the form of Ti^{2+} ions and potassium in the form of K^+ ions.

To summarise, a proliferation of H or D atoms is produced which have reduced electron path radii. These atoms appear to be a relatively unreactive species (referred to hereinafter as "U-toms"). They do not seem to readily take the molecular form H-H or D-D. This is a fortunate property which is highly significant as it is believed to enable fusion to occur, as discussed below.

The fusion of light nuclei such as hydrogen or deuterium to form

heavier elements such as helium, is one which has traditionally been encouraged by subjecting the reactants to extremes of temperature and pressure. This has been necessary because there is a large electric charge barrier to overcome in order to bring nuclei close enough for fusion to occur.

Within the electron path radius of the spherical shell of charge which surrounds a D or H nucleus, the effective electric field is zero. The charge density distribution of the proton is given by:

$$E = +e/[4\pi\epsilon_{(0)}\ r^2]$$

and that of the electron path by:

$$E = -e/[4\pi\epsilon_{(0)}r^2]$$

and, when $r > a_o$, this field resolves to zero.

Thus, using "U-toms", as the electron path radius reduces, adjacent nuclei experience a corresponding reduction in electric barrier and internuclear separations may become smaller. With reduction in internuclear separation, fusion processes become more probable, and more easily occasioned.

There are two principle fusion pathways for deuterium atoms. The first is:

$$^2_1D + {}^2_1D = {}^3_2He + {}^1_0n$$

where two deuterium nuclei fuse to produce an isotope of helium and a free neutron, which subsequently decays (half-life 6.48 x 10^2 S), with emission of a ß$^-$ article of medium energy (about 0.8MeV), and a type of neutrino, to become a stable proton.

The second is

$^{2}_{1}D + {}^{2}_{1}D = {}^{3}_{1}T + {}^{1}_{1}H$

where the two deuterium nuclei fuse to produce the isotope of hydrogen known as tritium (T) and a free stable proton. The tritium eventually decays (half-life 12.3 years), with emission of a β^- particle of very low energy (about 0.018 MeV), to become $^{3}_{2}He$.

Of the two, the second fusion path is preferred for the peaceful exploitation of its energy yield, because the fusion products are (relatively) harmless on production, and decay to completely innocuous species within a short time, emitting radiation which can be effectively shielded by a thin sheet of kitchen foil or by 10 mm of acrylic plastics, for example.

When deuterium nuclei are forced together at high voltage under high temperature and pressure conditions (as in a thermonuclear bomb), there is a greater than 50% probability for the first pathway to be the dominant one. This is because the high temperature process takes no account of nuclear alignment at the point of fusion. It is actually a matter of forcing nuclei together indiscriminately and hoping that enough fuse to produce an explosion. However, the applicants believe it is the alignment of nuclei with respect to the neutron and proton in each nucleus which ultimately determines the favourable fusion path.

In order to achieve a higher probability for the second, less hazardous, pathway, the approaching nuclei need to have time to align such that the proton-proton separation is at a maximum. This can only be achieved at lower energies than those found in a thermonuclear bomb. By the use of "U-toms" of deuterium, with their potentially smaller intermolecular distances, fusion can be initiated at lower temperatures (and consequently lower energies), allowing for the charge-related alignment necessary to achieve a high probability for the second, tritium forming, pathway.

By introducing "U-toms" of deuterium into a plasma discharge which is confined within the electrolyte itself, fusion can be initiated. Temperatures of the order of 6000 K are obtained within certain plasma discharges and this, coupled with the multiple catalysis of a_o/n transitions to produce "U-toms" of deuterium, produces a substantial yield of energy from the two-stage process.

Another possible but less likely fusion pathway for hydrogen atoms is:

$$^{1}_{1}H + {}^{1}_{1}H = {}^{2}_{1}D + ß^{+} + \tau$$

whereby $ß^{+}$ is produced as one of the products.

Two embodiments of the invention will now be described by way of example and with reference to the accompanying schematic drawings, wherein:

Figure 1 shows an apparatus for carrying out a method in accordance with the invention on a relatively small scale; and

Figure 2 shows an apparatus for carrying out a method in accordance with the invention on a larger scale than that of Figure 1.

The apparatus of Figure 1 enables the generation of energy according to the principles of the invention in the laboratory. Any risk of thermal runaway is minimised, whilst demonstrating that the level of energy release from the two stages is far in excess of that which would result from any purely chemical or electrochemical activity. It also enables easy calorimetry, safe ducting away of off-gases, and of subsequent extraction of electrolyte for titration (to demonstrate that no catalyst is consumed during the operation of the apparatus).

A 600ml beaker 2 is provided with an expanded polystyrene surround 4 to act as insulation. This can include an inspection

cut-out so that the area around the cathode 6 can be observed from outside. The beaker contains 500ml of the catalyst electrolyte 8, which consists of a 6M solution of potassium carbonate in water. Such a solution is prepared by dissolving 829 grams of anhydrous K_2CO_3 in 1 litre of H_20 or H_20/D_20 mixture, using gentle heat to ensure dissolution, but allowing the resultant liquid to cool to room temperature in order not to confuse any calorimetry which might be undertaken. A platinum lead wire 10 is earthed to the laboratory reference ground plane, which also acts as the electricity supply undertaking's earth. The anode 12, a sheet of platinum foil of approximately $10mm^2$ in area, is attached to this lead wire 10 by mechanical crimping. A digital thermometer 14 is inserted into the catalyst electrolyte. The heating element 16 is a coil of insulated nichrome wire, sized to give approximately 100 watts of power when energised by its lead wires 18 from an external supply, which can be AC or DC. The purpose of this coil is twofold: first, it enables the electrolyte to be heated initially to the optimum operating temperature for the process, which is between 313 K and 353 K (40°C and 80°C); second, it enables a controlled input of electrically powered heat energy while the process is turned off, to demonstrate the effect of 100 watts of energy supplied in a conventional way, so that comparisons may be made.

A 0.25mm diameter tungsten wire cathode 6 is sheathed in borosilicate glass or ceramic tube 20 and sealed at the end immersed in the electrolyte so as to expose 1mm to 1.5mm of wire in contact with the liquid. The entire assembly of lead wires and thermometer is carried by an acrylic plate 22 which enables of easy dismantling and inspection of the apparatus.

A supply of 400 volts DC, capable of supplying up to 5 amperes, is arranged external to the described apparatus. The positive terminal of this supply is connected to the laboratory reference ground plane and the negative terminal is connected to one pole of a push-button make/break switch capable of carrying and interrupting a current of 5 amperes. The switch is of the

normally-open variety and must return to the open mode on release of the button. The other pole of the switch is connected to the tungsten wire cathode 6 externally of the apparatus.

To operate the apparatus, the electrolyte 8 is initially brought up to between 40°C and 80°C by either preheating outside the apparatus, or by passing 100 watts of power through the heater element 16. When the electrolyte is between these temperatures it is either transferred to the above apparatus or, if the heater is used, this is turned off.

With all connections made as described, the push-button switch is operated very briefly. It will be seen through the inspection cut-out that an intense plasma-arc is struck at or near the cathode. Repeated pushes of the button will produce further plasma-arc strikes. If equipment is available to monitor the current drawn, it will be seen that the system consumes in the region of 100 watts when the button is pressed. It will be seen by the rapid rise in temperature in the apparatus that far more energy is being released than can be accounted for by the electrical input. As a comparison, the heater element can be operated at 100 watts and the effects observed. There is really no need for sophisticated calorimetry to verify that fusion is occurring, such is the magnitude of the reaction.

Taking as a rough guideline that 500ml of deuterium oxide requires the input of 2105 joules of energy to raise it by 1°C, and a two-second pulse on the switch produces a temperature rise of some 12°C in the electrolyte, it can be seen that considerably more than 100 watts of electrical power is at work. Moreover, this takes no account of the light energy output of the plasma-arc itself, nor of any purely Faradaic electrolysis of the water, which is happening in parallel with the fusion processes in the apparatus.

A second apparatus for carrying out the invention is illustrated in Figure 2. This apparatus comprises a tubular chamber 24,

which may be constructed from a nonmagnetic metal or metal alloy material such as, but not exclusively, aluminium or Duralumin, or may alternatively be constructed from a non-permeable ceramic material or from borosilicate glass. The tubular chamber 24 is constructed in flanged form to allow of its incorporation into a system of pipework via flanges 26 and 28 and gaskets 30. Entering the chamber 24 are two electrodes, the cathode 32 being sheathed in an insulating glass or ceramic tube 34 and shaped so as to present itself along the axis of the chamber 36. The anode 38 is connected to a similar insulated wire 40 and is shaped so as to present a circular plate opposite the cathode 32. The distance between the cathode tip and the anode plate should be approximately equal to the radius of the chamber 24. The cathode may be constructed from tungsten, zirconium, stainless steel, nickel or tantalum, or any other metallic or conductive ceramic material which may contribute to, or occasion, the dissociative process described above. The anode may be constructed from platinum, palladium, rhodium or any other inert material which does not undergo any significant level of chemical interaction with the electrolyte.

Surrounding the chamber 24, and concentric with it, is a winding 42 of enamelled copper or silver wire of diameter 0.1 to 0.8mm consisting of up to several thousand turns of the wire. The purpose of this winding 42 is to create an axial magnetic field inside the chamber 24.

Electrolyte comprising deuterium oxide, in combination with ordinary "light" water in varying proportions, and containing high-molarity salts of, but not exclusively of, potassium, rubidium or lithium, or combinations of such salts, is pumped through the chamber 24.

The anode lead wire 40 is connected to the ground plane or zero volts. The cathode 34 is connected to a variable source of between 50 and preferably 2000 volts negative with respect to the grounded anode 38, but may be coupled to a voltage of up to

several tens of thousands of volts negative with respect to such anode 38. To enhance performance of the invention, the negative voltage may be supplied in the form of pulses having a duty cycle between 0.001 and 0.5.

The winding 42 is energised with an alternating voltage such as to provide a current flow of typically between 0.5 and 1.5 amps initially. The frequency of the applied alternating voltage should be variable from DC up to 15kHz and may, in addition, be synchronous with pulses applied to the cathode 32.

Under these conditions, a plasma arc will strike close to the cathode 32. The intensity and frequency of the current flowing in winding 42 may be adjusted to provide for the removal of the plasma arc from the immediate vicinity of the cathode 32 to avoid excessive evaporation of the material from the cathode 32.

The volume of electrolyte pumped through chamber 24 and past the plasma arc may be varied such as to stabilise the temperature of such electrolyte in a closed system at below at its boiling point.

Heat may be extracted from the electrolyte by passing it through a heat exchanger before its re-introduction into the chamber 24. Provision may be made to top-up the water/deuterium content of the electrolyte as this becomes depleted by operation of the apparatus. The system may operate at a range of pressures to facilitate heat removal.

CLAIMS

1 A method of generating energy comprising the steps of providing an electrolyte having a catalyst therein, the catalyst being suitable for initiating transitions of hydrogen and/or deuterium atoms in the electrolyte to a sub-ground energy state, and applying a voltage across an anode and cathode in contact with the electrolyte.

2 A method of generating energy comprising the steps of providing an electrolyte having hydrogen and/or deuterium atoms and a catalyst therein, the catalyst comprising an ionic species which provides an energy couple of a multiple of approximately 27.2 eV, and applying a voltage across an anode and cathode in contact with the electrolyte.

3 A method of inducing transitions of hydrogen and/or deuterium atoms to a sub-ground energy state, comprising the steps of providing a liquid comprising hydrogen and/or deuterium atoms, and adding a catalyst which provides an energy couple of a multiple of approximately 27.2 eV.

4 A method of Claim 3 wherein the liquid is an electrolyte, comprising the step of applying a voltage across an anode and a cathode in contact with the electrolyte.

5 A method of generating energy comprising the steps of reducing the electron-path-radius of atoms of hydrogen and/or deuterium in an electrolyte and fusing said atoms within a plasma discharge generated by applying a voltage across an anode and a cathode in the electrolyte.

6 A method of Claim 5 comprising the step of including a catalyst in the electrolyte to provide an energy couple to the energy required to induce the emission of a photon from the atoms of hydrogen and/or deuterium.

7 A method of Claim 5 or Claim 6 wherein the fusion takes place at a temperature of approximately 6000K or above.

8 A method of any preceding Claim wherein the energy of the atoms is reduced to half their ground state energy.

9 A method of any preceding Claim wherein the energy of the atoms is reduced or further reduced to 1/3, 1/4 or 1/5 their ground state energy.

10 A method of any of Claims 1, 2 or 4 to 9 wherein the electrolyte comprises H_2O and/or D_2O.

11 A method of Claim 10 comprising the step of varying the ratio of H_2O to D_2O in the electrolyte to control energy generation.

12 A method of any of Claims 1, 2 or 4 to 11 including the step of heating the electrolyte to a temperature between 40 to 80°C prior to applying the voltage.

13 A method of any of Claims 1, 2, or 4 to 12 wherein the applied voltage is in the range 50 to 20000 V.

14 A method of any of Claims 1, 2, or 4 to 13 wherein the applied voltage has a pulsed waveform.

15 A method of Claim 14 wherein the pulses have a duty cycle between 0.001 and 0.5.

16 A method of any of Claims 1, 2, or 4 to 15 wherein the cathode is formed of a conductive material suitable for inducing dissociation of H_2O and/or D_2O to produce hydrogen and/or deuterium in monatomic form.

17 A method of any of Claims 1, 2 or 4 to 16 wherein the cathode comprises tungsten, zirconium, stainless steel, nickel

and/or tantalum.

18 A method of any of Claims 1, 2 or 4 to 17 wherein the anode is formed of a material which is inert with respect to the electrolyte.

19 A method of any of Claims 1, 2 or 4 to 18 wherein the anode comprises platinum, palladium and/or rhodium.

20 A method of any of Claims 1 to 4 or 6 to 19 wherein a predetermined amount of catalyst is used to control energy generation.

21 A method of any of Claims 1 to 4 or 6 to 20 comprising the step of adding more of the catalyst to increase the rate of energy generation.

22 A method of any of Claims 1 to 4 or 6 to 21 wherein the catalyst comprises cations.

23 A method of Claim 22 wherein the cations comprise ions of potassium, rubidium and/or lithium.

24 A method of any of Claims 1, 2 or 4 to 23 including the step of feeding the electrolyte past the electrodes.

25 A method of Claim 24 wherein the anode is positioned downstream of the cathode.

26 A method of Claim 24 or Claim 25 wherein after the step of feeding the electrolyte past the electrodes, the electrolyte is fed through a heat exchanger.

27 A method of Claim 26 wherein after the step of feeding the electrolyte through the heat exchanger it is fed back to the electrodes.

28 A method of any of Claims 24 to 27 wherein the electrolyte is fed through a chamber containing the cathode and the anode, the distance between the cathode and the anode being approximately half the width of the chamber proximate the electrodes.

29 A method of any of Claims 1, 2 or 4 to 28 including the step of generating a magnetic field in the region of the electrodes.

30 A method of Claim 29 wherein the field is generated by supplying power to a winding.

31 A method of Claim 30 wherein the frequency of the voltage applied across the winding is in the range from DC to 15 kHz.

32 A method of Claim 30 or Claim 31 when dependent on Claim 14 wherein the frequency of the voltage applied across the winding is synchronised with the voltage pulses applied across the electrodes.

33 A method of any of Claims 30 to 32 wherein the current fed initially to the winding is in the range from 0.5 to 1.5A.

34 A method of any of Claims 30 to 33 wherein the winding comprises wire between 0.1 and 0.8mm in diameter.

35 A method of any of Claims 30 to 34 wherein the magnetic field is arranged to cause the plasma arc generated adjacent the cathode to be spaced therefrom.

36 A method of any preceding claim wherein fusion occurs via at least one of the following pathways:

$^{2}_{1}D + {}^{2}_{1}D = {}^{3}_{2}He + {}^{0}_{1}n$

or

$^{2}_{1}D + {}^{2}_{1}D = {}^{3}_{1}T + {}^{1}_{1}H$

or

$^{1}_{1}H + {}^{1}_{1}H = {}^{2}_{1}D + ß^{+} + \nu$

37 A method of any preceding claim wherein the hydrogen and/or deuterium atoms are in monatomic form.

38 A method substantially as described herein with reference to the accompanying drawings.

Fig. 1.

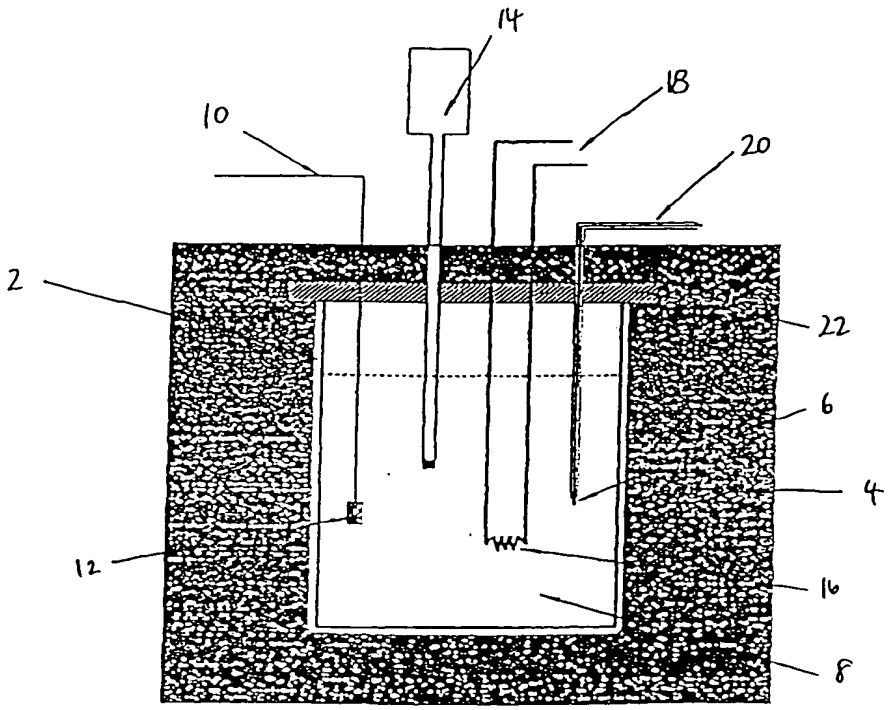
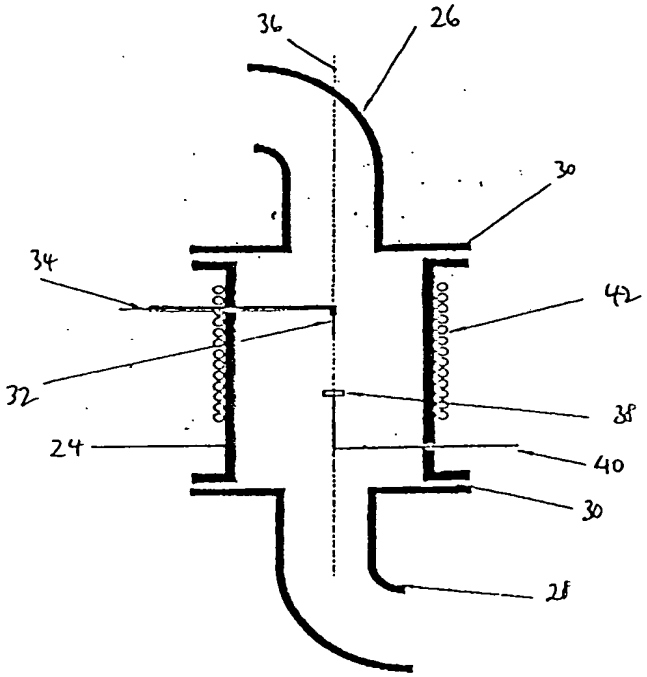


Fig 2.



SCALE